An Address
ON
THE ORTHOPAEDIC OUTLOOK IN MILITARY SURGERY.*

BY
COLONEL SIR ROBERT JONES, C.B., CH.M.,
INSPECTOR OF MILITARY ORTHOPAEDICS, ARMY MEDICAL SERVICE.

THE subject of this address is sufficiently comprehensive to fill a large volume, and I can only touch, and that very lightly, upon certain problems of interest. I shall, however, try to explain the orthopaedic mind in its dealings with surgical problems, and refrain from any discussion of the more abstruse principles.

A knowledge of the best way to correct deformities and restore function should involve a knowledge of preventive methods. The pathetic side of an orthopaedic centre is the collection of physical disabilities which should never have been. The inspiring fact is that in our experience hardly a case is found to whom we cannot offer help. In the early stages of the war we dealt exclusively with corrective orthopaedics. Now that we have convoys sent directly over to us we are becoming more and more profitably engaged on the preventive side.

One point which has impressed all who are seeing end results is the necessity that we should work in much closer association with surgeons abroad than we do at present. In this way we could approach problems from their point of view, and they would learn also of the later phases of their cases. It would strengthen judgement on both sides, and clarify and standardize treatment. Consultants on both sides of the Channel would find it a welcome relief to share each others' burdens. Such important questions as the primary excision of joints and fractures of the femur, and many others, require the closest consideration which can best be made productive by such co-operation.

From its original meaning the term "orthopaedic" would seem to have little application to military surgery. We know, however, that orthopaedic surgery in civil practice has long ago burst the bonds of its etymology. It has enlarged its borders chiefly in two directions—the operative and the educational. The aim of the orthopaedic surgeon is to restore functional use to disabled limbs. He has not merely to correct a distorted limb, but to help it to perform its function. A straight limb may be ineffective functionally, while a crooked one, under appropriate after-care, may be made extremely useful.

Orthopaedic surgery has enlarged its borders on the operative side by reason of the advances made in pathological, anatomical, and physiological knowledge, which have rendered it possible to perform operations leading to the restoration of physical function which, years ago, could not be considered. It has enlarged its borders in the educational direction by taking advantage of modern methods of restoring the function of the locomotor system by electrotherapy, massage, and wisely directed voluntary exercise. There is no definite operation which is essentially orthopaedic; there is no special appliance or apparatus which is the peculiar mark of the orthopaedic surgeon. A surgeon is judged good or bad from the orthopaedic standpoint by the results of his efforts to correct physical disability. Orthopaedic surgery is based on, and consists of, the recognition and practice of definite principles of treatment—whether operative, manipulative, or educational—which lead to the restoration of function in deformed or disabled limbs or muscles.

The orthopaedic mind thinks in terms of function. It has to deal with a pre-operative and a post-operative stage. The operative stage, although it may be essential, has only its proportionate value. For this reason, orthopaedic operations which are necessary preliminaries to re-education of function include the correction of gross deformities, the reconstruction of joints, grafting operations on bones, muscles, and tendons, and the repair of injured nerves. They include the maintenance of joints and limbs in proper position in order that injured tissues may recover functional efficiency. This is preventive. They involve also the correction of faulty positions of joints by manipulations most carefully conducted by splint or by graduated support. They should also include the prevention of those pathological displacements of joints which are found too often in our wards.

It behoves surgeons generally to expand their knowledge of the principles which guide us in orthopaedics, in order to lessen the necessity, or shorten the period of disability. The early wound treatment would include certain methods which involve an efficient fixation of the limb in the position best suited for usefulness.

In these days of operative exploits it is not easy to find the mind which will be sufficiently patient to undergo a training in the slow methods involved in this special kind of work. I deplore the loss of a number of young men who have failed to resist the lure of the abdomen, and who are now hopelessly lost in that productive cavity. They are badly wanted, but very difficult to deliver.

The orthopaedic surgeon must be tenacious, hopeful, enthusiastic, and very, very patient; or he fails to supply that psychological element which inspires his patient through the months of weary waiting so often needed before any results of treatment are apparent.

The conditions which, taken together, create an orthopaedic case may be classed roughly under the following heads:

1. The mechanical injury to bone, joint, muscle, or nerve.
2. The atrophy and disease of these structures primarily due to the injury.
3. Inco-ordination of movement due to disease of the brain—a result of atrophy and disease of peripheral structures.
4. Psychological conditions which can be overcome by re-educational processes.

The fact that about 50 per cent. of the wounded of this war have received injuries resulting in impairment of locomotor function and usefulness of limbs has brought the importance of orthopaedic principles and methods of treatment into a prominence which no one had foreseen.

The number of wounded men is so great that they form an economic problem, not only for the present but for the future. The problem for the present is how most rapidly to make the wounded man fit for military service; or, failing fitness for military service, how are we to make him become an independent self-supporting citizen and not a crippled dependant? The problem of the future is how the partially disabled man is to be kept as fit as possible after he has left the army. This last problem is for the Ministry of Pensions to solve, and a more momentous problem, fraught with so may possibilities of success or failure, has rarely existed. There should be no gap in continuity of treatment when the soldier leaves the army and becomes the care of the Pensions Ministry.

HOSPITALS AND ACCOMMODATION.

In the early stages of the war the sudden influx of large numbers of wounded men demanded a sudden expansion of hospital accommodation. At this time also the terrible sepsis of wounds from the battlefields of France presented a difficulty for which surgeons had not been prepared by previous experience. The severe septic injuries from which the men were suffering took a long time to heal, and the wounded from other big battles began to crowd into this country faster than the hospitals could be cleared by the normal discharge of patients fully cured of their disabilities.

The pressure on accommodation was such that from time to time various orders were issued for the discharge from the army of men who would not be fit for active service within a specified number of months. The result of this was that men were discharged from the army and from hospital as soon as their wounds were healed and their general condition allowed them to leave, but they were not cured of their physical disabilities. Consequently, the civilian population was steadily becoming more and more burdened with wounded men not fit to earn their living, and not likely to become fit until they had some further surgical treatment.

This was a state of affairs which presented grave dangers from the economic standpoint. As the end of the war began to seem more remote than at first thought probable, it became clear that this hasty discharge of wounded men must cease—not only from the point of view of national economy, but also from the point of view of military conservation of man power. There was no Pensions Ministry at this time to supplement treatment,

* Delivered before the Hunterian Society on January 2nd, 1913.

and the Statutory Committee never found its legs, so the responsibility again fell upon the shoulders of the War Office and room had to be found for the readmission of these discharged men. They included cases of malunited fractures, which required operative treatment; ununited fractures, many of which required bone grafting; old cases of nerve injuries requiring suture, and innumerable cases of stiff fingers, ankylosed joints, and contractures due to scars following septic wounds.

It was at this stage that Sir Alfred Keogh instructed me to start the first orthopaedic centre in Liverpool, with a view of concentrating under one roof a staff trained in orthopaedic principles and an equipment which could provide for all the stages of treatment necessary for the restoration of function. This enabled other hospitals to evacuate some of their worst and more tedious cases, and make room for more recent ones. We started in Liverpool with 250 beds, and we have now sixteen centres in the British Isles containing close upon 15,000 of our wounded. Of the men treated in these centres 75 per cent. have been returned to the army.

What is an Orthopaedic Centre?

An orthopaedic centre consists of:

1. A staff of surgeons who have had previous experience of the detail of orthopaedic work, both operative, manipulative, and educational. They plan the complete course of treatment.

2. Men with experience in operative surgery who, though not specializing in the work, are interested in it, and only need experience to fit them to take charge of wards in new centres as they are formed. We are always glad to hear of such men.

3. Still younger men who will ultimately go abroad. I cannot too strongly state the advantages which orthopaedic centres offer for the training of young men about to leave our shores. These centres might be made much more educational than at present with the greatest benefit to all concerned.

4. The hospital further consists of a series of auxiliary departments, each under a medical man who has experience of the particular methods of the treatment he directs. These departments are the electric, the massage, the hydrological, the gymnastic, and the curative workshops.

The successful working of an orthopaedic centre depends upon the coherent association of all departments in carrying out the plan of campaign mapped out by the surgeon when he sees the case.

Workshops.

Workshops have proved of considerable value in orthopaedic centres. They act directly and indirectly on the welfare and recovery of the patient. They act directly as a curative agent when the work done gives exercise to the injured limb, and can therefore be employed as agents in restoring co-ordinate movements. Equally valuable is the indirect effect of being put to useful work.

Discipline, however, was for long a difficulty. In orthopaedic hospitals a very large number of men can get about, and concerts, card-playing, and smoking soon cease to be interesting occupations for a man who is well in health except for a twisted hand, a disabled shoulder, or other disability. Some occupation was necessary, and the only one which presented itself was breaking rules and the mild excitement of coming before the commanding officer and the joy of having a grievance to grumble about. It is in this connexion that the curative workshop comes most actively into play.

Workshops are being instituted in every centre as part of the psycho-therapeutic treatment as well as for the purpose of re-educating injured limbs. Splint shops exist for making all the splints required by the hospital, carpenters' shops for making things needed in the hospitals, such as gymnastic plant, racks for *x*-ray negatives, and all the endless repairs and alterations required in a big and growing institution. Boot shops are required for making special boots and repairing those that are worn out, and electrical fitting shops for making and repairing apparatus required in the electrical department as well as keeping the ordinary light installation in order. To these manual occupations are added others, such as clerk orderlies to the medical officers to help in keeping records of cases, the proper filing of *x*-ray photographs, and so forth. In all this a point of great psychological value is that the work is productive and useful, it is work that has to be done by somebody, and the wounded man feels that if he does it at all it is worth doing well.

In prescribing curative work in the workshops—that is, work directly exercising the disabled limb—care has to be taken not to fatigue it and so impede recovery. At first every man was told to use his injured limb, but once the fact was recognized that over-fatigue might result and that the indirect use of the limb was giving better results, the workshop became more curative. In such cases the necessary amount of exercise of the disabled limb is carried out daily in one of the special departments, and later in the gymnasium.

In all these arrangements for employing a patient the value of his work as a producer is secondary. The important point is that the work shall be curative of his physical disability, and especially keep him from becoming an incurable idler.

For the initiation and equipment of all these shops and departments we are deeply indebted to King Manuel, while the generous help of the British Red Cross Society has been of inestimable value. Means of getting to work quickly were promptly forthcoming, and the success of the first schemes at once led to the supply of means for expansion and development.

THE SURGICAL SIDE OF THE WORK.

In the earlier stages the work of our orthopaedic staff included the rectifying of many deformities which might have been avoided; to-day these are becoming fewer as the fundamental principles of treatment of deformity are being earlier applied. The successful anticipation and prevention of pestilences is the most conspicuously successful feature of our medical services. A similar anticipation and prevention of deformity and disability as the result of wounds has not yet been achieved, and only when it has will the number of cases we now call orthopaedic be lessened.

The Causes of Deformity.

If the number of cripples and of cases of deformity is to be reduced we must examine into the causes of deformity and the difficulties which the surgeons in the field have to overcome. Thanks to the united efforts of pathologists, bacteriologists, and other workers, a partial victory has been won over sepsis, and now that the fear of death from sepsis is lessened, we must turn with greater assiduity to the problem of saving limbs and preventing deformity.

The orthopaedic problem can be divided, therefore, into two distinct parts—preventive orthopaedics and corrective orthopaedics. The latter is more especially the department of the trained orthopaedic surgeon, and I shall return to it briefly later. The preventive requires the help of every surgeon who has to treat wounded men at any stage, especially the early stage.

Gunshot Injuries of the Femur.

Gunshot injuries of the femur constitute, in my opinion, the tragedy of the war, not only by reason of the fatality by which they are attended, but also because of the deformity and shortening so often associated with them. Recent convoys show a marked improvement upon earlier ones, but much more remains to be done, and the question is very urgent. From abroad I have received bitter complaints of the want of continuity of treatment in this country; and, from our experience here, we are forced to the conclusion that while cases arrive from certain hospitals abroad most admirably fixed, they arrive from other places leaving much to be desired.

The question of fractures of the femur is essentially one of *preventive orthopaedics*. Our centres are constantly dealing with deformities following this injury. Many cases come with four or five inches of shortening and with every variety of deflection. Is there no way in which the better results could be multiplied, and the bad results avoided? I venture very respectfully to suggest that there is. It may involve difficulties in administration, but they should easily be overcome. From all one hears, the present mortality is far too high, and every effort should be made to standardize the treatment of fractures of the

femur on the most efficient plan. The remedy consists of leaving these fractures in the hands of specially trained men, who should be retained for this work only. They should proceed in association on a common plan. This is more than ever necessary now that it has been decided to retain these fractures in France.

Now what is the plan? First and foremost, the concentration of all fractured femurs in special fracture hospitals at the base. I would suggest that a large hospital should be reserved for these cases at each base. Each hospital should be staffed by well-trained surgeons with mechanical aptitude, desirous of devoting themselves to this special work for the term of their service. They should have security of tenure for two reasons. In the first place, more responsible or urgent work could not be found for any surgeon, and, in the second place, experience in the fracture service would constantly increase the rapidity and efficiency of their work. They should have selected nurses and orderlies to help them in team work, and they also should be protected from the danger of frequent changes. These fracture hospitals should be visited by an inspector of fractures acting in conjunction with the consulting surgeons of the various districts. No case should be evacuated in opposition to his instructions, and he should have a deciding voice in the selection or removal of any member of the surgical staff.

One or more of these hospitals should be chosen as an educational centre, and all young surgeons who can be spared from time to time should undergo training there. Certain nurses and orderlies should also be trained, and in this way teams prepared to do rapid and efficient work at the casualty clearing stations.

At present, fractures of the femur are found distributed in various hospitals—many in tents. Under these conditions continuity of treatment is impossible. Like an orthopaedic centre, a fracture hospital needs a thorough equipment. Surgeons, however able and conscientious, cannot do justice to a fracture of the femur when short of equipment and located in a tent. Even surgeons of very special experience, and they are few, are rendered comparatively impotent in these conditions. If these suggestions are followed, the saving in personnel would be very appreciable, for the work would be organized. A trained surgeon, an orderly, and a sister would do more rapid and efficient work as a team than half a dozen most excellent surgeons who do not possess this special experience. The training school could in an incredibly short time supply regimental aid posts and casualty clearing stations with teams of surgeons and orderlies taught to fix these fractures efficiently and with astonishing rapidity.*

Two fundamental principles must be sacredly adhered to:

1. Efficient fixation in correct alignment at the earliest possible moment.
2. Continuity of treatment.

Death, when it occurs early, is usually due to shock, the result of direct injury, the shock being often increased by exposure and the movement of injured tissues during transport. Fixation, therefore, should not be delayed a moment. For the purpose of rapid, simple, and efficient fixation there is no splint to compare with a Thomas. I learn that in many divisions these splints have now been supplied to the regimental aid posts. They should be supplied to all. These splints can be rapidly applied over the trousers and extension made by a pull on the boot. Twenty or thirty cases can be dealt with in an hour by a trained team of orderlies; I allude, of course, merely to the mechanical fixation of the fracture.

The wound is next thoroughly overhauled in the casualty clearing station. When this can be done with the limb well extended in the splint it is an advantage. This extension of the limb undoes all kinks and folds wherein discharges may collect. When the wound is thoroughly dealt with, and the limb fixed for permanent treatment, the case is sent down the line whenever it is safe. Experience has proved that, since such cases cannot be kept indefinitely at the casualty clearing stations, they should be sent down at the earliest possible moment after the recovery from shock, before sepsis has had time to spread and before the danger of secondary haemorrhage has set in. Cases do best at the base hospitals when they are received there during the first three days.

This secures for us the second important principle—continuity of treatment. The teams at the regimental aid posts, the casualty clearing stations and the base hospitals will have a common understanding, and no unnecessary change of methods is likely to occur.

How are we at home to continue the work in its final stage? An Army Council instruction has been issued directing that all fractures of the femur which come to this country shall be sent to orthopaedic centres, and in case these centres are full, to specially selected hospitals. If this instruction is faithfully obeyed our results will be enormously improved. Certain cases, however, continue to gravitate elsewhere. When this happens, I would ask surgeons to remember that, after gunshot fractures of the femur, the bones remain soft for several months after so-called union has taken place. This means that body weight on the unsupported femur will make it yield. Cases are now coming from France beautifully fitted with caliper splints which should be worn for many weeks. Some of these have been prematurely removed and bowing of the femur has resulted. Gunshot fractures of bones take a considerably longer time to harden than we have been accustomed to in civilian practice.

Both at home and abroad the defects of treatment run on similar lines—namely, inefficient reduction, fixation and extension. These defects will be mostly overcome by segregation and a carefully selected personnel. The orthopaedic centres with their equipment offer very suitable facilities, but as the numbers of these cases increase other general hospitals should be selected and supplied with whatever equipment is needed. Now that fractures are being retained abroad until they can safely travel, the railway journey on this side need not be considered. We must never forget the difficulties our surgeons abroad have to contend with, and that they have shown greater initiative and progress than we have at home. If opportunities could be extended enabling young surgeons engaged in this work in France and England to exchange visits, it would prove of great educational value.

Gunshot Fractures of Other Bones.

What has been said about fracture of the femur is true of fractures of other bones of the limbs. The danger to life is less, but the frequency of deformity is as great. There are one or two types of deformity which recur so constantly that some mention should be made of them.

In the lower limb, fractures of the bones of the leg are too often associated with a backward sagging at the site of fracture, due to inefficient support; or they present a valgus deformity at the seat of fracture, which is a very serious fault, for the body weight is deflected on to the inner side of the foot, thus producing the more serious disabilities associated with aggravated flat-foot. A bow-leg is a strong leg even if it is ugly, while a valgus leg is both weak and ugly.

Non-union, or delayed union, is far too commonly met with in fractures of the humerus. This is most frequent when the fracture is through the middle third. Two factors are mainly responsible for this—over-extension and inefficient fixation. If, for purposes of drainage and fixation, extension is used, it should never be excessive or prolonged; it is an easy matter to separate the fractured ends of the humerus by an inch or more if traction is severe. The other factor is inefficient fixation. Whatever splint is used, it should enable the dressing to be applied without disturbance of the fragments, and it should permit flexion of the elbow to considerably above the right angle. The prevailing deformity in fractures of the lower end of the humerus is a backward thrust of the elbow. This is best governed by flexing the elbow sufficiently. Fractures through the elbow-joint, in view of ankylosis, should be treated at right angles. It is in this fracture specially that care should be taken to keep the forearm about three-fourths supinated, for a pronated hand with ankylosed elbow is tragic.

In this connexion I may draw attention to two serious dangers in compound fractures of the forearm. One is vicious union between the two bones, and the other is sagging or convexity to the ulnar side. Both lead to impairment of pronation and supination. To prevent these deformities we should first make sure that the ulna is in

* I have been informed since delivering this address that many of the suggestions I have outlined have already been adopted at the front.

line, and then secure supination. Any theories we may hold in regard to the action of the pronator radii teres may be discarded, for pronation of the forearm is a direct invitation to cross union. It is a sound rule in all fractures of the upper limb to see that *the palm is towards the face when the elbow is flexed.*

GUNSHOT INJURIES OF JOINTS.

The results of primary excision of joints are filtering into the orthopaedic centres. I am not in the position to criticize the value of this procedure, but surgeons abroad should know that the functional results are very bad. Flail knees, flail elbows, flail shoulders—many of them suppurating—are constantly in evidence. They present a serious problem to the surgeon. We have been able to ankylose many of the elbows with good functional result. This is true to a lesser extent in the case of knees and shoulders. Some of the excisions of the knees well above the condyles and below the tuberosities leave very little in the way of bearing surface to work upon. Indeed, in those cases amputation is often justified. We must at once admit that any surgical procedure is welcomed which will save an amputation, and this is especially true of the arm. The artificial arm is a miserable substitute for a living one, however maimed, and to amputate an arm should be almost the heaviest responsibility a surgeon can assume. Primary exsections of joints or muscles are infinitely to be preferred to a loss of limb; but is amputation always, or often, the alternative? On that point we would like an authoritative pronouncement by the consultants abroad. If the conditions admit, it is obvious that the greatest conservatism in the treatment of joints should be practised, and, with the growing ascendancy which our surgeons abroad are gaining over sepsis, I cannot but think that routine excisions should be, and doubtless are, discouraged. A procedure which may have an exceptional value should be hedged by clearly defined instructions and limitations. Perhaps such instructions already exist. Do these excisions save life and limb? Is there not some way of so improving the fixation and drainage of these injuries that less drastic measures will suffice?

We constantly receive from certain sectors gunshot injuries to joints—especially knees and shoulders—where immediate excision of the *wound* (not the joint) has been practised. The results are often surprisingly good. At one hospital we had at one time five such cases of gunshot injuries through the knee, and in three of them a perfectly functioning joint resulted, while in both the others the wounds had healed without incident. If such joints had been subjected to primary excision, what a tragedy it would have been! Should these excisions be called for, an authoritative ruling on the matter is needed, clearly specifying the types that can be spared and those that must be sacrificed.

From the orthopaedic standpoint, I may offer a few suggestions as to the after-treatment of these excisions in order that we may secure a fair functional result. If the shoulder is excised, the arm should be placed in an abducted position at an angle of about 50 degrees. The elbow should be slightly in front of the coronal plane of the body, so that when it is at right angles and the forearm supinated, the palm of the hand is towards the face. The bones should be approximated by posture at an early date. If ankylosis occurs in this position, the arm can be lifted to a considerable height by scapular action. The arm should not be left hanging, as there is on the one side a danger of a useless flail shoulder, while on the other, should it become ankylosed, the movement will be very limited. If the excision should result in a flail shoulder, it should be ankylosed in the position I have just described.

The same principles govern our post-operative treatment of the elbow. Excision of the elbow-joint with complete removal of the condyles and of the olecranon generally leads to flail elbow—a most useless elbow to a working man. On the other hand, an elbow ankylosed firmly at nearly a right angle is very serviceable.

In treating such excisions of the elbow, I should advise that they should be kept extended and supinated during the early stages of drainage, then gradually flexed to a right angle, even if sinuses discharge. If the elbow is kept straight while a suppurating wound heals, there is a danger of ankylosis in extension. If there be no suppuration the elbow can be flexed from the first. The worst cases, for reasons which are obvious should ankylosis result, are those which have been kept straight with the forearm pronated.

In all gunshot injuries about joints, where ankylosis is feared, the arm should be placed in a position most useful for the patient in after-life: the shoulder abducted, as I have already described; the elbow at an angle of about 70 degrees flexion from full extension; the forearm nearly two-thirds supinated; the wrist in dorsiflexion, and the hip in slight abduction and external rotation with full extension; the knee in full extension; the ankle at right angles, and very slightly varoid.

INJURIES OF MUSCLE AND NERVE.

The importance of position becomes evident again in injuries of muscles and nerves. Torn muscles must not be allowed to become puckered by dense scars; the limb must be put in positions which will prevent the formation of undue contractures. This matter is one which calls for great judgement, and the surgeon should at the earliest stage encourage voluntary action of the muscle—not necessarily movement of the limb. No muscle will move voluntarily while the seat of an acute injury; so soon, however, as the injury is healed, the muscle can make movements, provided it is not heavily loaded. This is one of the important factors in re-education methods.

The surgeon has, therefore, to watch whether in the injured muscle contracture or overstretching is taking place, and act accordingly. Generally speaking, contractures occur in flexors and overstretching in extensors; but a hard and fast rule cannot be laid down, especially in positions in which gravity plays an important part.

In recovering nerve injuries, whether after bruising of the nerve followed by spontaneous recovery, or after suture for a divided nerve, the muscles supplied by the nerve must be kept continuously relaxed by splinting the limb: first, because paralysed muscles are easily overstretched, and overstretched muscles cannot contract; secondly, because relaxed muscles are more susceptible to returning trophic influences and are in a state to respond to the first feeble motor impulses that come to them through the recovering nerve. It is then that voluntary re-education can be begun. For the same reason all deformities which would impede the action of the muscle should be corrected as a preliminary to nerve suture unless this subsequent correction can be easily secured without straining the fresh union in the nerve.

CORRECTIVE ORTHOPAEDIC SURGERY.

If I have shown that the most important side of orthopaedic surgery in relation to military surgery is preventive orthopaedics, and that preventive orthopaedic treatment should be consciously and definitely recognized and practised from the moment the wounded man is first attended to, and then continuously thereafter, according to definite recognized principles, I have not entirely failed.

The question is, How are we to establish recognised methods?

One means already in existence is within our orthopaedic centres by encouraging the staffs of the various hospitals to meet and discuss their difficulties, their methods and their results, and by holding conferences at the various centres.

The next is, that each centre should be used as an educational centre, open to all who wish to see the methods practised there.

Surgeons home from the front should not merely spend one day out of their precious leave in going to look at the work because they have heard it spoken of, but some system should be organized by which all the younger surgeons should be sent for a few weeks to work in these hospitals; first, that they may compare the results with their expectations when they treated similar cases in the first instance on the field; second, that by observing and assisting in the work of corrective orthopaedics they may learn how to practise preventive orthopaedics. It must be remembered that a part of corrective orthopaedics consists in deliberately inflicting the original injury by operation, and then treating the case over again.

This is especially the case in the treatment of malunited fractures, where the operative treatment consists in remaking the original fracture and then setting it in better

position. The orthopaedic surgeon has the advantage that he waits until the risk of recurring sepsis is practically absent, but he labours under the disadvantage that scars and contractures have occurred as the result of the original sepsis, which make it difficult to get the bones into correct position.

The treatment of stiff joints, again, presents a whole series of problems. In civil practice after a sprain or injury of a joint a few adhesions often occur which interfere with its free action, and, moreover, any movement which stretches these adhesions causes pain. The treatment as a rule is simple—forced manipulation to break down the little fibrous bands of adhesions. This class of case very rarely occurs in military surgery—so rarely that I would almost say a surgeon without considerable experience of manipulative methods, when he is tempted to move a stiff joint after gunshot injuries, had better pause, reflect, and refrain. I emphasize this because I have seen so many cases in which joints have been forcibly moved with disastrous results. As an illustration, let us very briefly consider a series of hypothetical cases, types of which occur over and over again as varieties of stiff knee.

1. First assume that a small fragment of metal has penetrated the front of the knee-joint, tearing the capsule and aponeurosis, but has been removed and the wound has healed without suppuration. The movement of the joint later is limited by pain, localized to near the wound and a definite stop to movement. The knee is flexed under an anaesthetic and one or two definite snaps are felt and all is well. This is a simple case of a few fibrous bands about the capsule which were stopping movements.

2. Next we will take a similar injury followed by effusion and a brief mild suppuration in the joint, relieved by cleansing and very temporary drainage. The movement of the knee is limited on attempting movement under anaesthesia; no great resistance is felt, but there is a soft tearing sensation. The experienced surgeon stops at once. He is not breaking one or two bands but is tearing a diffuse soft fibrosis extending all through the joint, and the result of his assault will be the formation of a more dense fibrosis. By waiting until the pathological changes are ended, movement may be restored in gentle stages of persuasively conducted alternate attack and rest.

3. In another case a piece of shell has torn the quadriceps above the patella and the muscle is firmly fixed down to the bone. If the surgeon attempts to flex the knee forcibly, he runs a big risk of fracturing the patella; but if he puts the limb on a back splint, so as to relax the quadriceps completely so that there is no strain on the scar, and massages the scar, it may loosen in a few weeks and become merely a fibrous intersection in the muscle, and then movement of the knee may be commenced.

4. There has been a septic fracture of the femur, and the quadriceps, especially the vasti, have become infiltrated first with toxic fluids and later by a matted fibrous tissue. Any attempt to stretch that by force is doomed to failure and will probably lead to a fracture of the patella. The best way of attacking such a case is to apply a splint which will allow of gradual flexion in stages. It may take two or three months to restore a range of movement of 45 degrees. With that range of movement the patient can walk with a little knee action and not merely with a stiff leg. After that, by use and help, he will gradually get more and more movement in the knee as the fibrous tissue in the muscle becomes absorbed.

There are other types of extra-articular obstruction which require operative attack. This is especially the case in the elbow and knee. The obstruction is usually found in a thickened capsule very much shortened, or in muscular adhesions. The extended elbow may require the free exposure of the capsule and its division, with perhaps a plastic elongation of the triceps. By similar methods the knee may be approached. The elbow or knee is then kept for a fortnight flexed. One rule must be strictly adhered to: If a stiff joint has to be moved under an anaesthetic, the bones above and below the joint must be protected. *This is especially called for where a fracture has existed.*

I have spoken of the reconstructive function of an orthopaedic surgeon, and to make this attitude clear we will take a hypothetical case.

A case is presented with an ankylosed shoulder, elbow, and wrist, with the potentialities of movement confined to the thumb and two adjoining fingers. The shoulder is adducted, the elbow extended, the wrist palmar-flexed, the muscles ischaemic. The question arises, Can any use be made of this apparently useless limb, or should it be amputated? On inquiry, the surgeon finds that the patient can shrug his shoulder—the scapular muscles are acting. The first procedure is to develop power in the thumb and two fingers, then to ankylose the wrist in dorsiflexion, and the elbow at the angle best suited to the patient. An osteotomy is next planned, in order to get the arm abducted. In a few weeks the scapula carries the humerus through a long range of movement, and the patient has secured a limb much more useful than the best of artificial arms.

Time will not allow me to touch upon the interesting problems of scars, transplantation of bones and tendons, pseudarthroses, and many other allied themes. Enough has been said, however, to lay bare the orthopaedic mind. It strives for function rather than for form, but is more content if it can secure excellence in both; it is conservative and constructive, but it desires to take the most direct road to function—be it by knife, by hand, or suasion.

I cannot conclude without paying the highest tribute to the loyalty and enthusiasm of my American and British staffs all over the country. If I sometimes try to direct their thoughts, I hope I shall never hamper them in their endeavour to solve the fascinating problems that surround them. Finally, I wish to express my deep gratitude to my professional brethren everywhere, who have neither by word nor deed done aught but encourage me in my work and lessen my labours. Without their help and confidence and kindness I should, indeed, be powerless.

ON THE SEPARATE SUTURE OF NERVES IN NERVE TRUNKS.

By J. N. LANGLEY, Sc.D., F.R.S.,
PROFESSOR OF PHYSIOLOGY, CAMBRIDGE.

THERE are a considerable number of factors which determine the degree of recovery from the effects of nerve severance. One of these factors is the accuracy of apposition of the central and peripheral ends of the severed nerve fibres. In man, all the nerve trunks consist of bundles of nerve fibres; each bundle has its own perineurial sheath, and is surrounded by epineurial connective tissue. The relative position of the nerve bundles alters gradually in their course in the nerve trunk. It is in the highest degree improbable that an exact apposition of corresponding bundles can be made even in a freshly cut nerve, and if a piece has been excised it is certain that exact apposition never occurs. Further, microscopic examination shows that after suture the nerve fibres growing out from the central end of any one bundle usually take a devious course, and run to several peripheral bundles.

In all cases, then, in regeneration after nerve suture, the connexion of the central nervous system with the peripheral tissues will differ to a greater or less extent from the normal connexion. The new arrangement caused by nerve fibres growing out of their course is spoken of as the distortion of the nerve pattern. The nerve pattern is distorted both on its efferent and on its afferent side. On the efferent side the central nerve cells which formerly in a limb controlled solely, say, a flexor muscle, may after regeneration control flexor, extensor, adductor, abductor or rotator muscles in varying proportion. On the afferent side cutaneous fibres normally giving rise to the different sensations of cold, heat, touch, etc., will run to muscle and tendon, and muscle and tendon afferent fibres will run to the skin. The straying of nerve fibres into others having a different function may possibly to some extent be lessened by the central fibres growing more readily into fibres of their own class than into fibres of a different class, but experiment shows that such selective direction of growth, if it occurs, is not sufficient to prevent nerve fibre of any one function growing into the peripheral end of a nerve fibre of any other function. Some readjustment of the processes in the central nervous system must, then, take place in order that reflex and voluntary movements may occur in a properly co-ordinated manner. The readjustment takes place fairly rapidly in the case of simpler movements, such as flexion and extension of the limb,[1] but finer movements are only gradually recovered and the sensory adjustment appears to take a still longer time.

In regeneration after nerve suture there is not only distortion of the nerve pattern, but a varying degree of loss of innervation. Besides the nerve fibres which grow into the connective tissue surrounding the nerve bundles of the trunk and surrounding the trunk itself, a more or less considerable number grow from efferent fibres into afferent fibres, and from afferent fibres into efferent. These can make no functional connexion with the nerve